

TRANSPORT in the year **A.D. 2000**

**I. Mech. E.
London
Automobile
Division**



The cover illustration is an artist's impression of the Ford Levacar, a wheelless vehicle that slides along rails on a thin film of air and is capable of speeds up to 500 mile/h, and is reproduced by permission of the Ford Motor Company Limited.

TRANSPORT

IN THE YEAR

A.D. 2000

A DISCUSSION ARRANGED BY THE
AUTOMOBILE DIVISION AND HELD
AT THE INSTITUTION ON 22ND
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Foreword

Sociologists predict that the world population will have doubled by the end of this century. In this country the population is expected to reach 70 million. Already the demands on our limited land are causing serious problems in housing and transport, and many roads are incapable of carrying more traffic. To accommodate the increased population, new towns will have to be planned which must be designed to allow convenient access for all forms of transport.

Professor Colin Buchanan, who made a forecast of the problem in the Government report entitled *Traffic in towns: a study of the long-term problems of traffic in urban areas*, opened a discussion sponsored by the Automobile Division of the Institution of Mechanical Engineers on 22nd February 1965. The comments made at this meeting cover a wide range of transport problems and town planning, and have been made available in this booklet so that the subject can be more generally appreciated.

Foreword

The first of the two volumes of this work is devoted to the study of the history of the development of the theory of the structure of the atom. The second volume is devoted to the study of the history of the development of the theory of the structure of the nucleus of the atom. The first volume is devoted to the study of the history of the development of the theory of the structure of the atom. The second volume is devoted to the study of the history of the development of the theory of the structure of the nucleus of the atom.

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Transport in the year A.D. 2000

Mr J. G. Withers (Chairman)

I extend a hearty welcome to you at this discussion entitled 'Transport in the year A.D. 2000'. We have many distinguished guests here tonight and are very pleased to see them.

The topic is a very interesting one for all of us. Even though not all of us in this hall will live to the year 2000, we can pave the way for our children and can to an extent control the future in the matter of design and so on. We are hoping that views on this will be put forward tonight.

Our opening speaker, Professor Colin Buchanan, is well known to you and without further ado I will ask him to make his contribution.

Professor C. D. Buchanan

We are apt to think of the year 2000 as lying in the dim and distant future, but in fact it is a mere 35 years ahead – well within the lifetime of many people in this hall tonight, and well within the lifetime of many buildings now being erected. Looking backwards, a period of 35 years takes one back to 1930, a date which in some ways seems to me as though it were only yesterday. In other words 35 years is not a very long period, and there is nothing fantastic even in a world of rapid change in trying to project the mind forward over this period and to visualize what the state of affairs will be. Indeed, if we do not try to make intelligent anticipation of some of the changes, it is likely that our affairs will get into greater and greater confusion.

Transport in the year 2000: obviously it is no use trying to think about transport as if it were an isolated activity in its own right. The transport or movement of people and goods is merely a manifestation of the activities which take place in our human society. People move from one place to another because they are impelled to do so by some reason – to visit friends, transact business, attend the dentist, see a girl, or perhaps just to find a place in the sun. Goods (I use the term broadly to cover raw materials, commodities, and finished or half-finished articles

of every kind) are moved from one place to another because they are required in the second place for some process of manufacture, storage, sale, or exchange. Always it is the case that movement is the result or product of activities. The kind of movement that takes place depends very largely but not wholly upon the locations, kinds, and intensities of human activities. It is not *wholly* dependent upon human activities because these activities tend in certain circumstances to be influenced themselves by the problems of movement and the adequacy or inadequacy of movement systems.

So if we want to consider the question of transport in the year 2000 it is imperative that we first try to visualize what the activities of our society will be at that time.

Now although one hears stories of how automation and other new processes are going to alter our lives completely in the next few decades, I am not at all sure that the next 35 years will in fact see many staggering changes. I say this because I cannot see any likelihood of great changes in the fundamental things of life. In 35 years time people will, I imagine, be roughly the same shape and size as they are now, they will still need to eat and drink, they will still start as babies and grow old, they will need shelter, warmth, education, and care in sickness, and I expect the mainspring of life – making love – will be going on in much the same way it has done for thousands of years. There will still be buildings to be built and rebuilt, food to be grown and imported and distributed, a vast variety of articles to be manufactured, laws to be passed, accounts to be kept, administration to be carried through, livings to be earned, and leisure to be enjoyed. Hours of work may be less, factories may be manned with fewer people, people may be ranging the world for their holidays, but on the whole I doubt whether the activities of life will be dramatically different from today.

If activities remain the same in principle then we may be sure that the movements generated by those activities will remain the same in principle. But there could be (1) dramatic changes in the *location* of activities which would alter the *pattern* of the movements; there could be (2) subtle changes in *social habits* which would affect the *kind of movements* that take place; and there could be (3) developments in *methods of movement* which could re-act back on *social activities*. Of these three possibilities by far the most important is the location of activities. What is likely to be the pattern of settlement by the end of the century? Will the bulk of the population be concentrated into four or five high-density conurbations, or will there be a diffusion of population all over the country in one great sprawl?

For myself I think it is now open to us deliberately to contrive the deployment of population and activities in the way that suits our

requirements best. Most of the legal machinery for achieving this is already in existence, and has been so for nearly twenty years. The problem is to know what to do with these powers, to decide what arrangement of population and activities *will* suit our requirements best. This is a highly complex matter, but I think it is possible to see certain things fairly clearly. Firstly there are social and economic advantages (in the kind of highly industrialized society that we are bound to remain) in urban concentrations or towns. One of the most important advantages, very germane to our subject, is that concentration reduces the need for movement by the reduction of distance, though the intensity of concentration must not be so high that movement itself is impeded. Secondly, at any rate this is a view to which I subscribe myself, there are advantages in this small country in preserving a distinction between town and country, and in conserving a particularly delectable countryside not only for agricultural purposes but also (which is probably more important) for the recreation of a predominantly urban population. In my view this makes a powerful case against the sprawl and spread of urban areas. Thirdly it has to be recognized that by the end of the century there will be another 20 million people to be accommodated in this country, and somehow we must do this *without* creating a sprawl. Fourthly it has to be remembered that though there is a great deal in our existing towns that is worn out and needs replacing, yet there are vast assets in them – material assets such as roads, buildings, drains and sewers, and intangible assets such as history, character, and atmosphere. None of these can be lightly abandoned, and my forecast is that our existing towns will go on for many a long year, though subject to constant adaptation to new needs. Fifthly I think there will be advantages in resisting the over-concentration of activities in the south-east of the country – not only for the sake of the south-east itself, but to avoid the social and economic impoverishment of the rest of the country.

So, by the year 2000, I foresee a pattern of settlement which in many ways will not be unlike the pattern we have today. But there will be some dramatic additions to it in the form of new towns and cities to accommodate the 20 millions increase of population. Where we put those new towns, and the form they will take, will be matters of great importance and interest, and I suspect that considerations of facility of movement will be crucial to both aspects.

Within this pattern of settlements many familiar 'tensions of movement' will result. The gravitational attraction of one town on the next will still be felt, there will still be the long-distance cross-country movements, there will still be, doubtless on an ever-increasing scale, the movements connected with recreation. Whatever new movement

systems we may devise, and this is really the main subject of our discussion, my guess is that people are not going to be easily put off using the most versatile machine for movement which has yet been invented. I refer of course to the motor vehicle. By the year 2000 we could be getting very near the stage of 'saturation' of car ownership, the situation when everyone who desires a car has the means to possess one.

In this brief introduction I have attempted to outline the shape of activities as they may be in the year 2000. There will be great changes, of course, but I do not share the view which some people hold that developments in telecommunications, etc. will completely alter the pattern of our lives. As I said earlier, most of the basic needs of life will continue unchanged in the course of 35 years.

In conclusion I should like to throw in one suggestion. It is that questions of movement will loom so large in all our decisions affecting the use of land and the location of new towns and urban expansions that the time has come when a 'National Movement Study' should be initiated on a permanent basis. Analytical techniques have now evolved to the point when such a study for the whole island is a practical possibility. I visualize it as a continuing organization, gathering data all the time, studying new methods of movement, and constantly predicting the consequences for movement of new development in this, that, or the other locality. In the past, though we have been guided by many factors in the selection of sites for new projects, we have tended to assume that transport would work itself out in some way. Now it is becoming clear that transport, or facility of movement, is one of the most important factors of all.

Mr S. H. Grylls

Dr Fremlin, of Birmingham University, has recently predicted in *The New Scientist* the state of affairs which might obtain by about the year 3000 if population were to continue to grow at the present rate. By then 60×10^{15} inhabitants of the world would be housed in 2000 storey buildings covering the entire surface of the land and sea. Dr Fremlin adds that horizontal travel would be limited. We obviously need not consider transport by the year 3000 at all, but if tonight we were discussing transport in 2100, or even 2050, we might be completely disheartened and decide that the problem was insoluble. By choosing the year 2000 some real problems obviously exist and some people here tonight will be able to see whether they were successfully solved.

Professor Buchanan has outlined the situation for which we may be heading: he expects expansion of the population and increased ownership of cars according to extrapolation of today's statistics. His figures agree very well with forecasts from other sources. Although the title

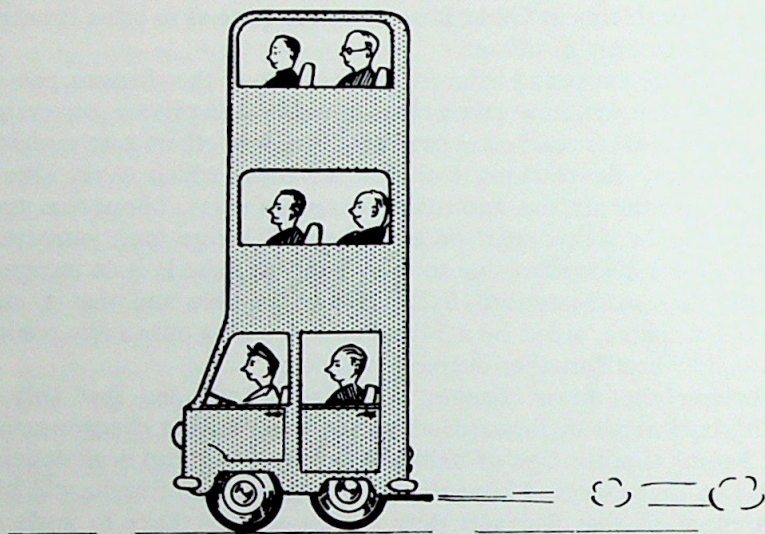
of this discussion might well take in the whole world or even outer space, the problems in Great Britain are the same as in other countries, but not necessarily in phase.

You may be expecting from me a prediction of the changes, possibly large ones, that will have taken place in public and private conveyances by the time 2000 is reached. I prefer to leave it to others here tonight to tell us of any far-reaching technical advances which could alter or revolutionize the air, sea, and road carriages of today. I hope that we do not have to be dehydrated or anaesthetized before long journeys to withstand the discomfort due to ever higher speeds. It is an intriguing thought that man-powered flying is just possible and that a man-powered machine, aided by a 5 hp motor weighing only a few pounds, would allow us all another degree of freedom.

I believe that most changes take place slowly and that only by looking backwards or forwards about ten years are big changes noticeable. I think that the cars of 2000 will look as if they had been designed for use on motorways. I hope that some segregation of traffic will have taken place so that fast and slow vehicles do not have to jostle for position on main roads. Possibly we shall be able to see through fog with the aid of equipment which only occupies a small space in the motor car. The inside of cars will no doubt have been improved so that the result of an accident will be less serious, but it is more important that accidents should be prevented by clever planning of the use of vehicles, including any device which makes it easier for a driver to know what is going to happen to him next. For instance, there is now no way of knowing whether the car ahead is slowing down gently or doing an all-out emergency stop. Failure to detect this difference in time makes a collision inevitable. I still dream of an 'anchor' which is independent of the coefficient of friction between tyres and roads. The only 'anchor' so far devised is somewhat anti-social!

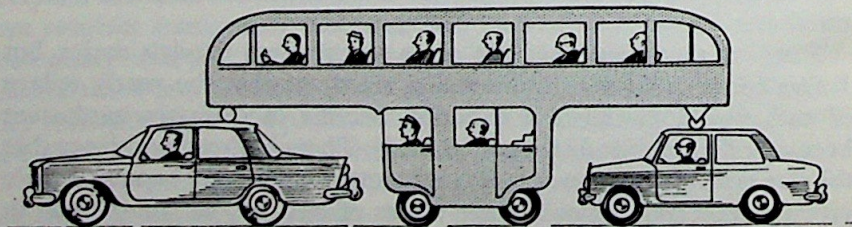
To distract you for a moment from more serious matters, I have included in my contribution two pictures, the first of a car that might be the dream of the Roxbee-Cox Committee but a little unstable, and the second of a car which might give temporary advantage to an early purchaser.

I believe that ownership of a car is almost every family's desire, but I also believe that this desire would recede or that the yearly mileage of cars would diminish if motoring became increasingly unpleasant because of continuously congested roads. There is already evidence that the use made of cars never leads to a complete standstill because people give up motoring or move their places of business or holiday just in time. Le Chatelier's principle appears to apply to motoring as well as to the physical changes for which it was originally stated. Automobile



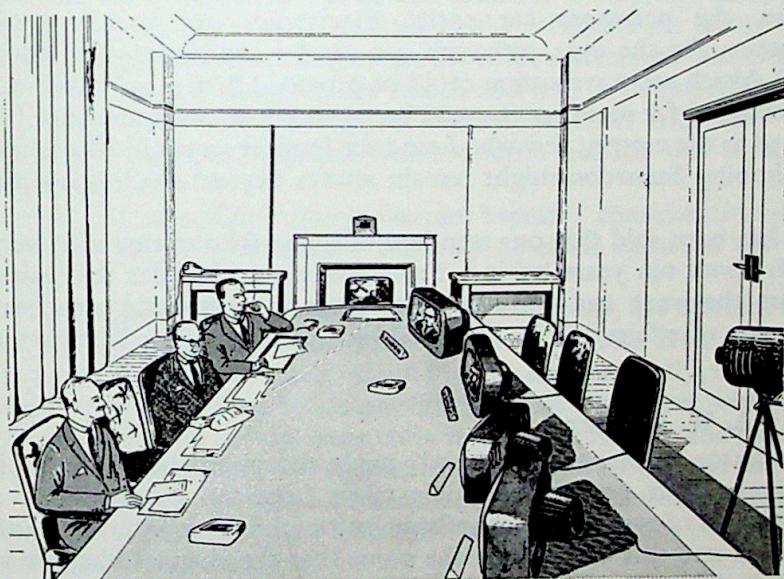
... the dream of the Roxbee-Cox Committee

manufacturers upset the equilibrium by selling more cars. More roads and more carefully planned use of cars result. The price of cars has so far lagged behind inflation because production has continuously increased at a greater rate than inflation. Should this ever not be so prices will rise disproportionately, causing sales further to decrease. The sea and the air are unlikely to become too crowded although docks and airports will have to be increased in number or in size. Roads are another matter and I do not expect personal road transport to be replaced by lots of tiny aeroplanes. I should therefore like to enlarge on a few matters concerning road transport.



... might give temporary advantage to an early purchaser

Motoring seems to be indulged in for three reasons: pleasure, business, and commuting. The last of the three I leave to Professor Buchanan, except again to point out that it will not reach saturation. I fully endorse the suggestions in the Buchanan report, but their implementation retrospectively would have to sweep aside an almost infinite inertia. New towns will, I hope, be built on the Buchanan principle. Although his report on *Traffic in towns* puts forward a plea that we should not indulge in half-way solutions, I do suggest that a breathing space could be achieved by greater use of multi-storey car



TV application in the board room

parks, by the abolition of street parking, and by the creation of far more one-way streets and the elimination of many right-hand turns. Double-decked roads separating delivery vehicles from cars on the move are obviously worth consideration. Motorists will have to learn to walk again, up to a quarter or even half a mile. My wife prefers the struggle of motoring from shop to shop, whereas I make straight for a car park where, incidentally, there is far less likelihood of damage to my car.

Business motoring from Monday to Friday is going to be replaced by electronics. The picture I now show you could soon be a reality. The people present at the 'meeting' are in several different factories and have moved only from their offices to the conference room. I am sure

that electronic engineers will find enough wave guides or will evolve multiple use of wave guides to make this state of affairs commonplace. The discussion that we are attending tonight might well take place while each of us remains in his home surrounded by a few cathode-ray tubes.

Pleasure motoring, or should I say motoring to somewhere pleasant, nowadays mainly the seaside, involves motorways to the coast, car parks at the resorts, and enough seaside to enjoy oneself. The amount of motoring to existing pleasant places could be reduced by scattering over England new recreation areas, both scenic and sporting with, of course, the necessary car parks. Electronics can already provide recreation for the eyes, although not yet for the senses of touch and smell. Much more recreation could be provided than is provided today; for instance, far more sport could be televised, actual attendance being limited to the esoteric few who found the journey worth it. The pleasure of climbing Snowdon might remain always beyond electronic simulation.

It has been said that our standard of living follows that of America, but is about ten years behind. From this we could infer that cars are not on the wane and will even get bigger. Accustoming ourselves to this state of affairs will be achieved by a mixture of Le Chatelier and electrons.

Mr A. W. Manser

Professor Buchanan has already made the point that 35 years is a relatively short period. The time taken from the conception to the completion of major road or railway improvements is seldom less than 10 years and this emphasizes the point that the changes likely to take place in 35 years are not so dramatic as might at first be considered probable. From the railway point of view, likely changes in transport by the year 2000 seem to fall into two categories, those on long-distance railways and those on suburban.

On long-distance high-speed services the trend will be towards the increase of average speeds by improvement in motive power, elimination of speed restrictions, and reduction in the number of stops. Undoubtedly the most advanced example in the world today is the Japanese Tokaido Line, all the characteristics of which point the way for future long-distance rail travel. As to speed, comfort, and traction performance, the Line is in advance of any other of comparable length in the world today. One point of particular importance is worthy of mention: the alignment of this railway has been planned so that the minimum radius curve is 2500 m.; the designed maximum speed for operation being 250 km/h.

In some of the wilder rail schemes suggested in recent years, there has been a disregard of this relation of radius of curvature to maximum speed. Clearly, it can be taken that for a conventional two-rail system with a limit on the maximum permissible cant, the minimum radius of curve for good riding will vary as the square of the speed. The provision of curves of adequate radius is very important in an alignment for high-speed operation and necessitates the sort of ruthless attitude to the project which is evidenced in the Tokaido Line.

As to the motive power, I suggest that, by the year 2000, use of electric traction will be general in this country. Whatever other means of energy production may be devised in the meantime, it seems likely that electric transmission will remain the most convenient and efficient means of conveying energy to the trains, and it is to be hoped that, by 2000, the enormous advantages of electric traction will have been adopted generally in Britain, in which electric traction was so largely pioneered.

Urban and suburban railways warrant separate consideration. Here electric traction is inescapable. 'Electrify or close' must be the only attitude.

The provisions will need to be of two types: firstly, the services from outer suburban stations to in-town terminals, where relatively high average speeds of 50-60 mile/h should be the aim; secondly, the urban, or rapid-transit services, which provide for local movement within the inner suburban and central areas. It is remarkable how, in the past few years, a world-wide acknowledgement has been growing of the need for the establishment or improvement of these metropolitan railway systems. No more remarkable examples can be quoted than those of Los Angeles and San Francisco.

In Los Angeles, a giant area planned on the basis of a highway system built to facilitate all possible movements by motor car, it has now been recognized that the highway system alone cannot provide the complete answer to the transport problem. Plans are now being developed for the building of a metropolitan railway.

In San Francisco, as recently as 1956, the 'Key' system lines across the Bay bridge were closed down and the space occupied by them given over to road users, in the belief that this would provide better utilization of the space on the bridge.

Now, within 10 years, the Bay Area Rapid Transit Development is pushing ahead, with all the characteristic American drive and initiative, to produce what promises to be the most advanced rapid-transit system in the world.

As with the Tokaido Line for express main-line operation, so we may look to the Bay Area Rapid Transit Development as providing the

indications for likely progress in the years to come: greater acceleration, higher speeds, air springing, automatic operation of trains, with only limited human monitoring, long welded rails on the track, with audio-frequency track circuits, eliminating the need for block joints, programmed operation of junctions, automatic revenue collection, and, most important, ready facilities for access from large car parks directly to the metropolitan railway stations.

This emphasis on the need for expansion of metropolitan railway systems by no means implies that the motor car will not continue, with every justification, to increase in popularity, but the figures speak for themselves. Take London as an example: with all the road congestion which occurs at peak hours today, barely 10 per cent of the total influx of people into London is by private transport and, with an estimated increase of more than 150 000 office jobs in the central area of London by 1981 – which is more than the total brought in by private transport today – it is clear that the need for additional underground railway services will be vital.

In development of its underground system London is by no means in the forefront. Paris, where no part of the central or inner suburban area is more than 8 minutes walk from a station, is far better placed. In London, the Victoria Line now under construction is the first new underground railway project to be carried out in the central area for more than 55 years! This pattern will need drastic revision if London is to continue as an example of what is good in the planning of a big city. At the moment, a survey of underground lines under construction in large cities throughout the world shows London to be fifth on the list as graded by mileage. If planning is taken into account, it is clear that many other cities are looking much farther ahead.

The pattern of transport in big cities in A.D. 2000 will be determined very largely by the scale on which additional underground railways, with adequate car parks at peripheral points, are provided. Without this provision, the pattern will be a disorganized one, with road users, both private and public, largely frustrated by chaotic traffic congestion.

Mr F. J. Lloyd

I wish to speak about London's buses in the year 2000, which is 35 years ahead. In 1929, 36 years ago, a procession of London General Omnibus Company buses through Central London celebrated the centenary of the London bus, and in this same year the 'L.T.' type bus made its first appearance. This was the first London Transport bus to be designed for pneumatic tyres and with a roof to the upper deck as an integral part of its body – unlike previous buses with solid tyres and open tops.

Our present Routemaster bus embodies countless mechanical and constructional improvements over the L.T. It is better for the driver, better for the conductor, better for the passenger, and carries (a few) more people.

But operationally the R.M. is the same animal as the L.T. – a vehicle providing seats for the majority of its passengers, on two decks, carrying a small number of standing passengers, operated by two men, with a staircase and open entrance at the rear.

In the last 35 years the system of fares and the method of fare collection have changed only slightly as preprinted tickets and the bell punch have been replaced by the portable ticket-printing machine.

I expect a much greater change in the next 35 years. The private motor car is rapidly becoming part of our way of life as its numbers and use increase year by year. The problems associated with the growth in the use of the private motor car in cities are becoming known and in the U.S.A. we can get an idea of the future and the measures necessary to enable us to live with the motor car.

At one time a London bus stopped anywhere for a passenger and it was customary to enter or alight by the open rear platform. With the growth in vehicular traffic on the roads and the introduction of one-way streets, the opportunity to hop on a bus has lessened and this year London Transport will experiment with buses basically different in operating design, as follows.

The high-capacity front-entrance double-decker with doors and staircase at the front. In the Central Area of London this bus will be operated with a conductor, and he will have more time to collect his fares because the driver will control the front doors. In the Country Area of London this type of bus will be used in off-peak periods, carrying passengers on one deck only without a conductor.

The high-capacity single-decker to be operated by one man. In the Country Area this bus will be used in a similar manner to the existing smaller single-deck buses which do not carry a conductor. In the Central Area this bus will be designed to carry two-thirds of the passengers standing. Moreover, the passengers will enter the bus through passimeters, paying their flat fare by placing a coin in a slot. Operationally it would be used to move large numbers of people for relatively short distances from, say, Victoria to Marble Arch.

The intention of these experiments is to compare these types of buses with the existing London Transport buses and to see how suitable they are for use in London.

When our existing ticket machines are replaced the new machines will, among other improvements, include computer tape inside the machines

to record the transactions. I expect electronic tickets, as designed for use on the Underground automatic fare-collection system, to come into use on the buses.

As a humble operator in a distinguished company of engineers, I am quite sure that in technical efficiency and performance – in its motive power, its suspension, its brakes, its steering, its riding, its heating and ventilation systems – the bus of 2000 will be infinitely superior to its forerunner of 1965.

There are certain conditions which are likely to affect the development of the bus, and first and foremost among these may be the possible radical changes in London itself which Professor Buchanan has outlined. I say 'may be' because even in 35 years the plan will not be fully achieved. But whether or not the plan is achieved it will not be possible to increase much the use of the private car for essential journeys to and from work in the inner central area of London. I believe that most of these journeys will continue to be made by public transport. I expect there to be several new tube lines and increased suburban services on the main railway lines, with an increasing need for buses to move people between their homes, the railway or tube stations, and their places of work. There will be need for much improved interchange arrangements between rail and bus, and tube and bus. I hope the town planners will accept the need to provide such facilities, which can enormously help the passenger who is changing between these forms of public transport.

Unlike many American cities London has as yet no motorways into the inner area. When these motorways are built the Green Line Coaches will be given a new lease of life: this year we are introducing some new 36ft coaches capable of greater speeds and giving the passenger greater comfort than existing coaches. As in America I expect to see coach services operating into and out of the inner area based on the motorways. They will be limited stop services and may be manned by a driver only.

But what of the red buses' future? Here I am torn two ways. The two-man double-decker bus gives the high seating capacity and the comfort to attract the customers. The 'standee' vehicle uses one man instead of two (and crew costs are over 60 per cent of total costs of bus operation), but reduces the standard of bus comfort. Perhaps by 2000 we shall have reached a two-way compromise. On the one hand, the standee bus, with flat fare, may cater for all short-distance traffic within the inner area of Central London and provide feeder services to and from railheads and other interchange points throughout the London area. The large double-decker, with its much higher standard of passenger comfort, may provide longer-distance services between the

suburbs and the centre, and cross-country between suburb and suburb, still probably with differential fares. I would hope, however, that the fare system would become less complicated than our present one and so help the use of some form of electronic tickets.

To return to our three types of operation for 2000: the standee single-decker for short-distance work, the large double-decker for longer distance, and an extended coach service on the motorways: this concept makes a radical change from our present network of bus services in London which itself has in general (as distinct from detail) altered little in at least 30 years.

The traditional London bus route, starting in a northern or western suburb and crossing the heart of Central London to a distant terminus in the southern or eastern suburbs, is likely to be altered by the close of this century. This type of route has had the great merits that it caters economically, all along its length, for many overlapping passenger traffics and that it needs no terminus in Central London, where places for buses to turn and stand are hard to find.

But bus routes of this type are the worst affected by growing street traffic congestion, and delays in, say, the Finchley Road, result in long gaps in service between Norwood and Crystal Palace – to mention Route 2 which has worked between its present terminals, with minor variations, for 40 years or more.

The other disadvantages of this type of bus route is that it may serve a number of short-distance local passenger traffics well and economically (though in practice, because of street traffic delays, unreliably) but, because of its continual stopping and low speed, has little attraction, and cannot compete with the private car when it comes to the longer-distance passenger, especially the commuter between suburb and urban centre or suburb and suburban centre.

Perhaps I still have time to mention one further rather fascinating aspect of the future. From 1870 to 1952 a competitor of the bus in London was the tram, a vehicle which operated on the streets but on its own special track, albeit a track on which other road-users were permitted to trespass. From 1931 to 1962 another competitor was the trolleybus which had no track but was tied to a fixed wire. The tram and trolleybus gave way to the bus because of the latter's flexibility and freedom from a fixed track.

Today, and of great necessity, there is a growing acceptance of the principle that the bus, because of its very high passenger/road space ratio compared with the private car, deserves a reserved lane, or priority of road use in some form, to enable it to avoid the effects of traffic congestion and so provide a regular and reliable service for the great majority of people travelling on the roads. And so we almost turn full

circle and try to give the bus, like the tram, a track of its own. This would seem to lead towards a channeling of main bus routes into a more limited number of roads than they at present use.

But, in the mists ahead, I see clearly the need for public transport if London is to continue to be as important and great a city as it is today.

Mr K. Summerfield

Tradition. At Magdalen College, Oxford, the undergraduates have to walk along the cloisters in their dressing gowns to get to the bathrooms. I call this poor transport planning.

Tradition preserved. Five centuries later the journeys we make to the office or our wives to the shops are just about as well organized.

And the reason. The human animal has survived on its adaptability. Adaptability can go too far. It makes us put up with conditions which we really have the intelligence to improve. Often too its just because we prefer things the way they are.

Consequences of the motor vehicle. The motor vehicle is a novel feature in the human environment. We desire it, we need it, and yet it baffles us. We can cope reasonably well with it in the countryside but it has made nonsense of traditional town organization. Should we mould the town to its need or shape the vehicle to our will?

Planning ideas of the past. If planning is the organization of the environment for the individual and common good, then we have in this century shown little genius for it. We have realized no concept to measure for stature against the square and the amphitheatre of the ancients, the village green and the quadrangle of the middle ages, or the park and boulevard of the 18th century. Even the Victorians knew how to handle their transport problems better by stopping the main-line terminals short of the centre of the metropolis and providing a highly-organized underground system connected to them.

The truth is that we are bedevilled by the idea of the street as the unit of urban organization. Nothing could be more intractable as a basis for a transport system. First the street is attenuated when it should be compact. Secondly, it has two sides, which means having to deal with crossing traffic as well as with turning and stationary traffic on each side. Thirdly, because of its lack of focus, it does not lend itself to two-level treatment, but involves miles of elevated pavement or elevated motorway.

And of the future. Planning for traffic means throwing the concept of the street overboard. It means a search for new basic units of urban layout. The most promising is the linear circuit. This is in effect a ring with all the development inside it and with an open space in the middle.

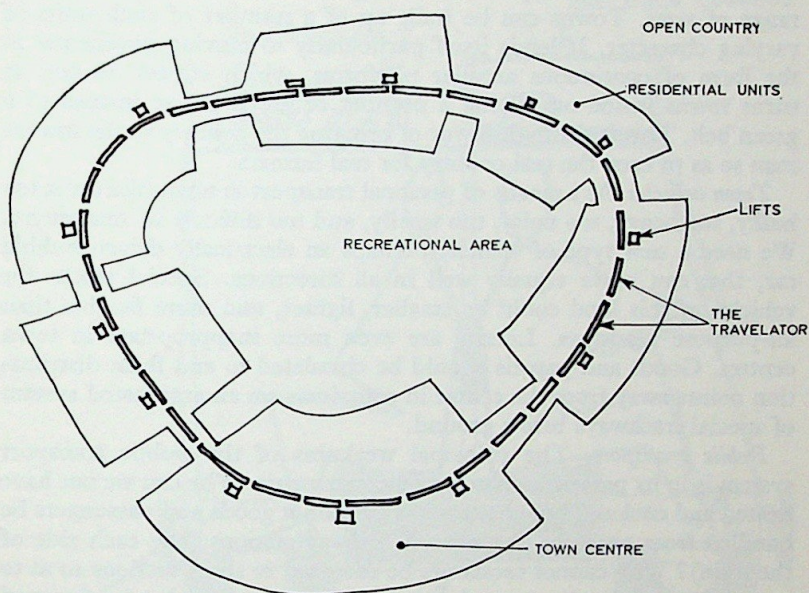
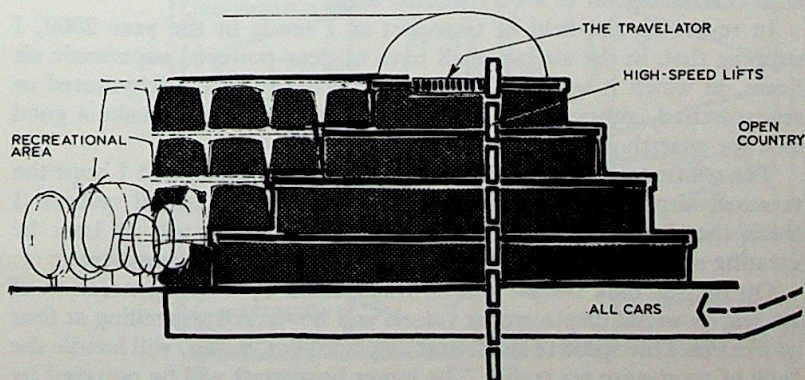


Diagram of the linear circuit



Section through part of linear circuit

This concept can be exploited in many different ways and in a wide range of sizes. Towns can be built up of a number of such units of varying character. It lends itself particularly to moving pavements in the form of continuous annular platforms, which streets do not. It turns towns inside out giving a number of green hearts instead of a green belt. This is the logical way of bringing the country to the townsman so as to keep the real country for real farmers.

Town vehicles. As a means of personal transport in towns the car is too bulky, too heavy, too noisy, too smelly, and too difficult to manoeuvre. We need a new type of vehicle, perhaps an electrically driven bubble car, that can move equally well in all directions. Special tracks for vehicles of this kind could be smaller, lighter, and more flexible than all-purpose roadways. Lorries are even more inappropriate in town centres. Goods and parcels should be circulated to and from distribution points away from the centre in containers on an automated system of special trackways below ground.

Public transport. The principal weakness of the public transport system is in its passenger-handling arrangements. Why can we not have heated and enclosed bus shelters? Why cannot goods and passengers be handled from separate platforms at railway stations (one each side of the train)? Why cannot escalators be designed in short sections so as to accelerate and decelerate at the ends? Why should ticket buying and punching take so long? Perhaps all this is asking too much, and one should be content if the year 2000 sees Oxford station repainted.

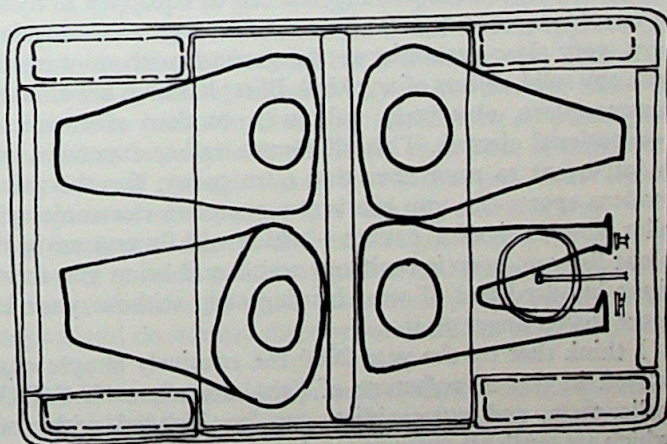
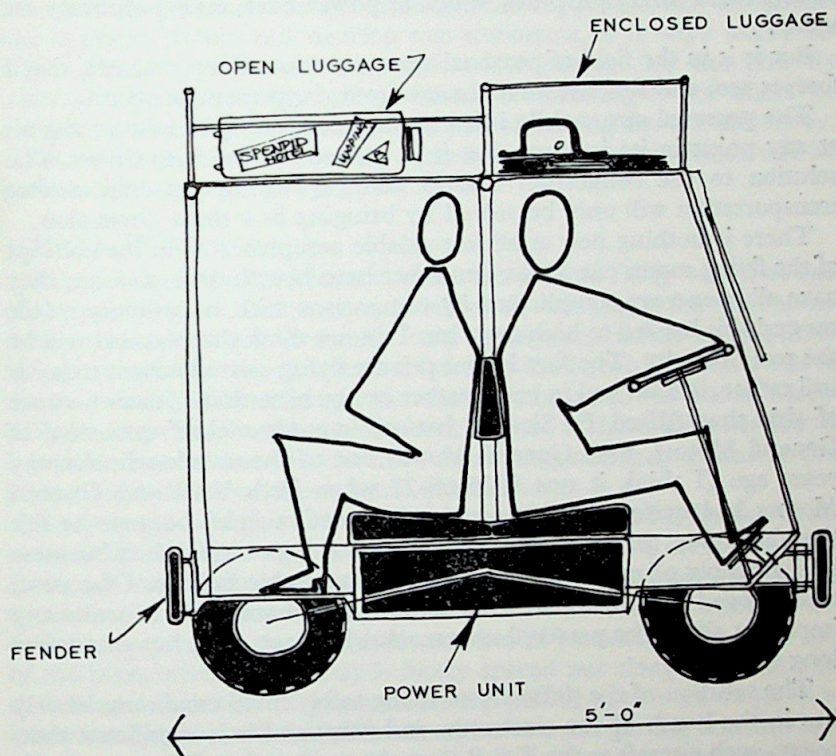
Mr N. D. Norman

My contribution is briefer than those of previous speakers because I shall confine myself to a very limited field.

In reviewing the field of transport as I see it in the year 2000, I suppose that, in the air, we shall have nuclear-powered supersonic air liners, in which it will not, I hope, be necessary to be dehydrated or anaesthetized, although the modern ones we have today make a good case for anaesthesia.

The continents will be linked by supersonic air liners and I hope the terminal airports will be linked by an extensive monorail system. I think that by the year 2000, hypersonic transports will at least be creating a severe problem in airline board rooms, if not elsewhere.

On the sea bulk freight will be transported by a new generation of nuclear-powered displacement vessels and hovercraft, travelling at four or five times the speed of the fastest displacement vessels, will handle the bulk of coast-wise sea traffic. The larger hovercraft will be powered by nuclear engines and the smaller ones by gas turbines incorporating efficient heat exchangers. Small hovercraft will probably be used for



Suggestion for a town vehicle

pleasure and utility purposes, much as power boats and speedboats are today.

But it is in the field of personal transportation, the motor car, that I foresee real and fundamental change from the present pattern.

The personal automobile is, in my opinion, going to take to the air at any point in its journey that it is convenient for it to do so. The solution to the congestion that is taking place in personal surface transportation will only be solved by bringing in a third dimension.

There is nothing new at all in roadable aeroplanes or in the concept of the flying motor car. Quite a number have been built but so far, they have all been very complicated by comparison with an ordinary motor car and this has led to high cost; but I do not think that the cost will be the real difficulty. The fact is that private flying as we know it today is still rather difficult and in bad weather can be hazardous. It was because of this that Alfred P. Sloane, Junior, long-time chief executive of General Motors, took General Motors out of the aviation field many years ago (I think it was 1925-26-27 when both Ford and General Motors had quite a big interest in the aviation field) because he felt that the flivver, the personal aeroplane, was going to affect their business in the supply of motor cars in some unpredictable fashion. Of course, time proved that flying was too difficult and hazardous to make any impact at all on the personal user market in those days, but that was a long time ago.

The solution of the difficulty of flying safely in all conditions clearly lies in the hands of the electronics industry, and it is significant that, today, such aircraft as the T.S.R.2 can be equipped to fly automatically in conditions of complete darkness and fog, at tremendous speed, in very, very close proximity to the ground, with no danger of collision with any solid objects of any kind. Blind landings are already completely commonplace, absolutely safe, with modern electronics systems in conventional aircraft. This all sounds rather expensive but I think it is important to remember that even today, for the price of a good modern sports car, you can buy a complete electronic system – autopilot, auto-navigation system – which will fly and navigate your aeroplane for you, keep it positively stable and bring you to within two or three hundred feet of your landing strip without your having to lay more than a finger on it.

I think that by the year 2000 the relatively simple engineering involved in the manufacture of light aircraft, or V.S.T.O.L. aircraft, helicopters, and automobiles, can be blended with the electronics which are available today to produce a machine at reasonable cost which will enable anybody who really wants to travel any distance, to ascend when he likes and proceed through the air. Roadable aeroplanes have

been built before and I do not think there is any reason why a mechanical engineer should not develop one tomorrow, if it were worth his while. Fairly soon it may be worth while because we can now fly automatically in complete safety without even having to see where we are going, which is more than can be said of driving down a motorway.

One other prediction I would hazard is that these machines will be just as difficult to park as are cars today.

Mr H. Perring

The previous speakers have covered the ground fairly well, but one of the points which seems to me to be worth stressing is the fact that in urban transport, we will remain very largely dependent upon public transport and that there are several forms of it. Here in London we have the so-called surface railways, the underground, and the buses. Many daily journeys involve the use of more than one of these. Like Mr Lloyd I believe that we have to use a lot more imagination in planning the interchanges between these forms of transport.

An example of a good interchange is at Hammersmith Station. You come in from North-west London on one line, get out on to the platform, get into a train on another line, and go on. But what happens at a station like Waterloo is really quite fantastic. Everything seems to be designed to produce the maximum number of bottlenecks. You get out of the train, where everybody is nicely spaced out along the length of the train, and instead of going across the platform, or even down to a lower level by a number of different staircases, and getting into another train, or into buses, you have to go through one gate so that the ticket-collector can see your ticket; you then have to walk for some appreciable distance, which may be healthy exercise but it is under very poor conditions, and are forced to line up in some way to buy another ticket to get on another train or bus. Much of this marshalling of passengers arises from the need to buy separate tickets for each form of transport. With more general use of through tickets we could approach the whole question of the layout of interchanges in a radically different way.

I feel that we must give a great deal of thought to this question of interchanges in order to make journeys quicker and more pleasant and thereby to produce a situation in which many more people are attracted to public transport and do not use their private vehicles to get into the city.

On the question of buses there is at present a conflict on the question of size. The economics of operating and the availability of platform staff, particularly drivers, is leading the trend towards larger buses. This is quite all right in the central areas and at peak periods when the big buses can carry a lot of people and can still run fairly frequently but it

tends to mean that, in off-peak periods, there is an undesirably long interval between buses. Here we may find that other developments could come to the assistance of the bus operator because with increased automation in the factories there could be more men available for the services. It may then be possible to get enough drivers to be able to run buses of less than maximum size so that more can be kept running in off-peak hours, with a welcome reduction in the average waiting time for a bus.

There are other more immediate things which I am sure we shall see before we come to the year 2000. I will limit myself to one, which is the idea of the buses having entrances and exits on both sides so that bus stops can be arranged on either side of one-way streets. As things stand at present, with the entrance on one side of the bus, if a one-way street goes past a railway station and the railway station is on the right of the bus, the stop still has to be on the left with the result that all the passengers have to cross the busy road; whereas if the bus also had doors on the other side, it could pull over to the right-hand side of the road and pick up and deposit its passengers without their having to cross the road.

There is another situation where doors on both sides can be helpful and that is when you are getting close to a junction. In general, there are attractions in having bus stops close to junctions. At present, if there is a stop just before the junction, it must be on the left of the road even though the bus has to turn right as soon as it moves off. This is most awkward for both the bus and the other traffic and could be avoided if the stop were sited on the right-hand side of the road.

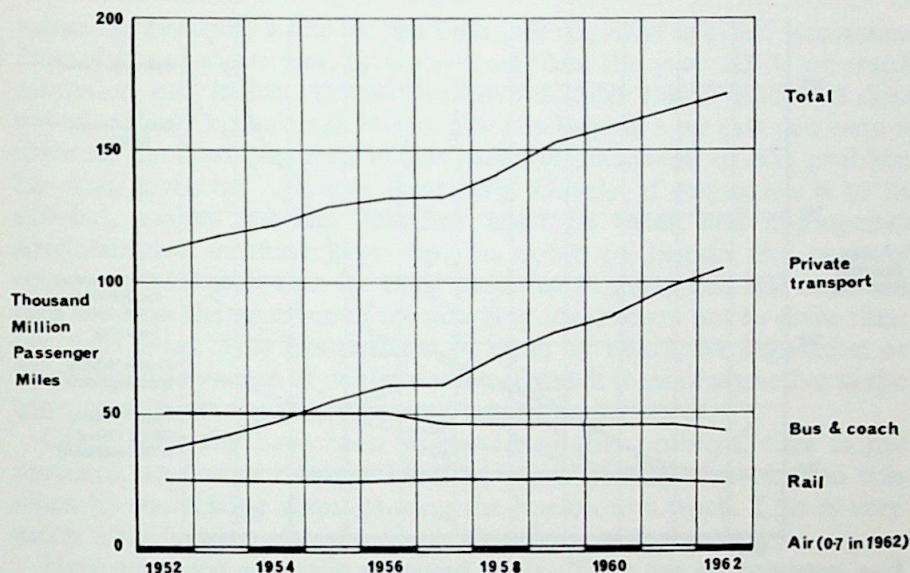
Mr R. S. Taylor

I think that before looking forward to the year 2000, it is worth while looking back, at least very briefly.

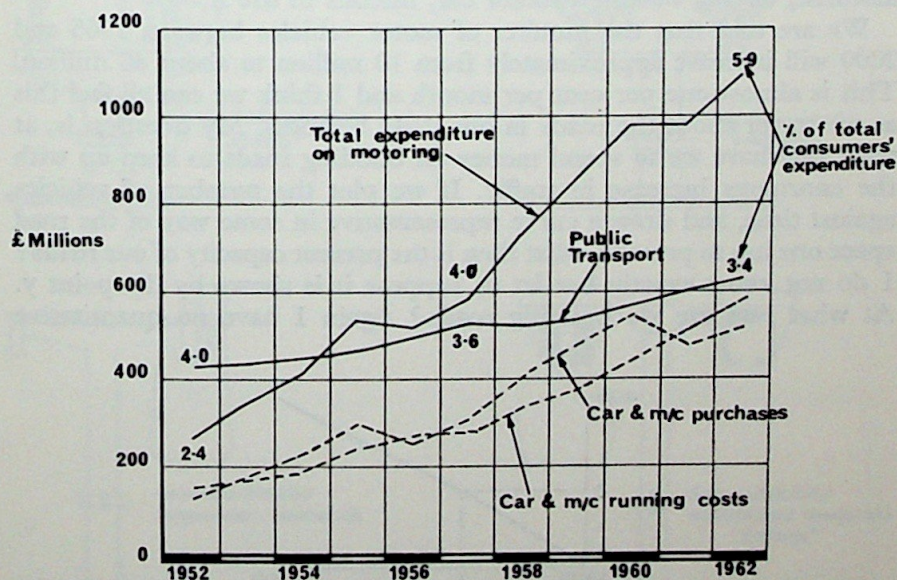
The first graph shows that during the period 1952-1962 rail travel has remained constant; bus and coach travel has declined slightly; private transport through the agency of the motor car has increased dramatically.

The second shows consumers' expenditure on transport and travel. The expenditure on motoring has increased in the period 1952-1962 by a factor of approximately 4, whereas expenditure on public transport has increased only by 50 per cent and the total percentage of consumer expenditure taken by public transport has fallen.

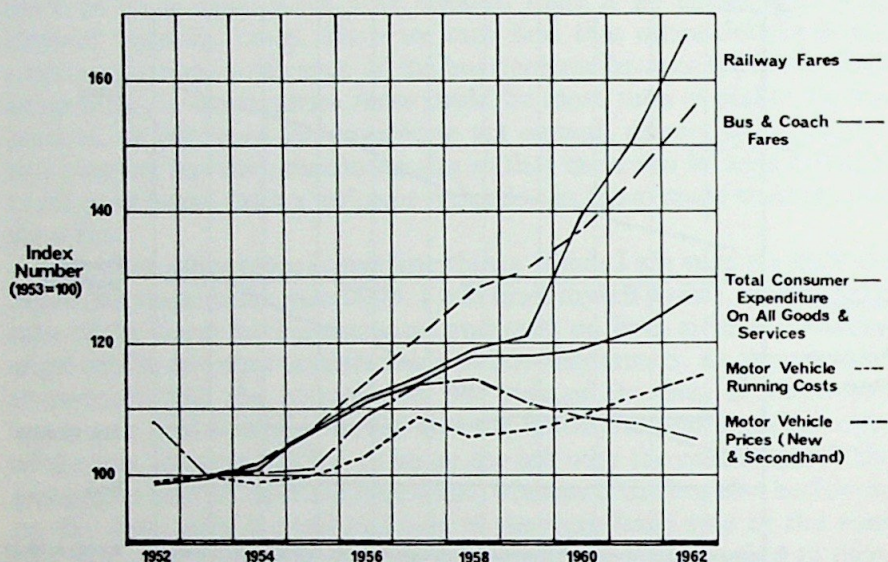
The third graph attempts to show, over the same period, the cost of transport to the consumer. The base line shows total consumer expenditure on all goods and services and we see that rail, bus, and coach fares have increased significantly, whereas the cost of motoring has, if



Total passenger transport in Great Britain



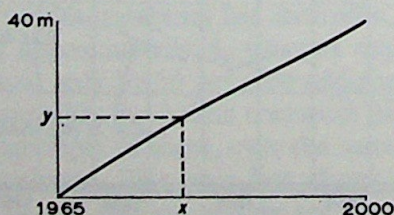
Consumers' expenditure on transport and travel



Passenger transport: cost to the consumer

anything, decreased relative to the base line. I think this shows that the motorist, having bought a motor car, intends to use it.

We are told that the number of motor vehicles between 1965 and 2000 will increase approximately from 10 million to about 40 million. This is almost one per cent per month and I think we can all feel this as we travel about the roads in our daily business. My question is, at what rate have we to spend money on building roads to keep up with the enormous increase in traffic. If we plot the number of vehicles against time, and draw a curve representative in some way of the road space one has to provide, what then is the present capacity of our roads? I do not know exactly but let us suppose it is shown by the point y . At what rate are we building roads? Again I have no quantitative

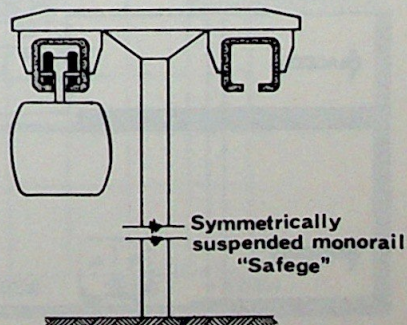
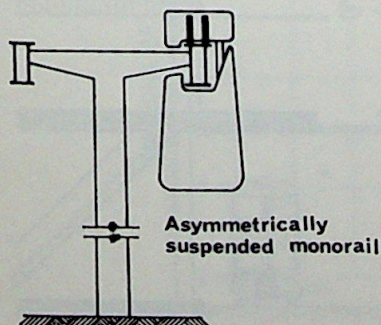
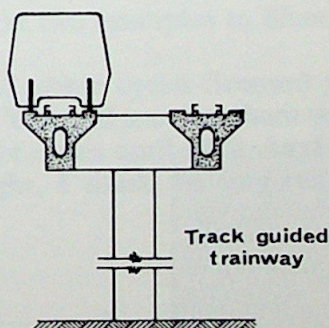
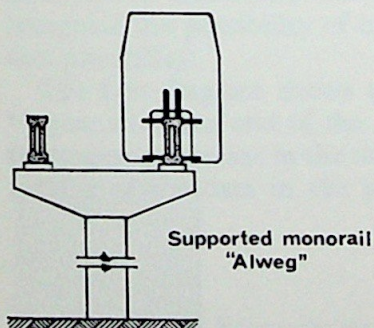


Increase in number of vehicles on roads of Great Britain

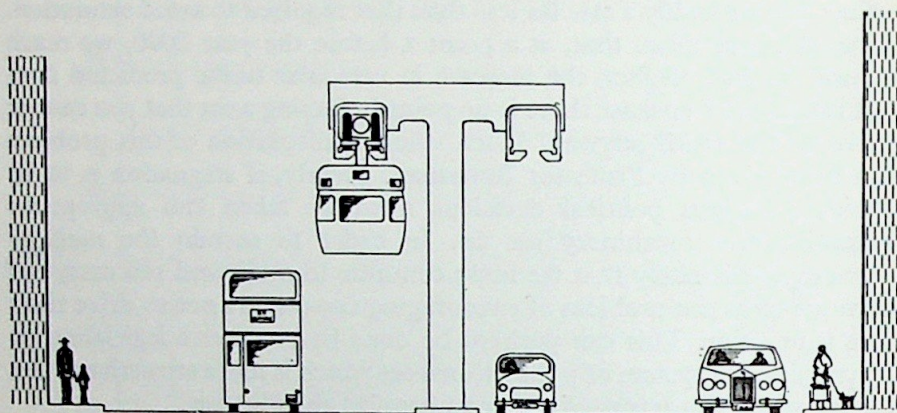
values but probably a rate far less than that required to avoid saturation. Does that not mean that, at a point x before the year 2000, we reach saturation and, in fact, the increase in vehicular traffic predicted does not take place? because there is no point in buying a car that you cannot drive on the roads anyway. Much valuable discussion of this problem has been given by Professor Buchanan. Clearly, if stagnation is to be avoided, serious political decisions must be taken and appropriate administrative machinery set up. In order to sustain the national economy, it is likely that we must continue to make and sell cars, but then we have the problem of encouraging car-owners not to drive their cars into cities. This can perhaps be done by restrictive legislation or by providing a system of public transport which is more attractive to the town traveller in terms of time and comfort than his car.

Other solutions have been suggested to this problem. One is the monorail. In fact, I thought Mr Lloyd was getting very close to this when he was talking about putting the bus on to a track. This is very much what is done with the monorail system of transport.

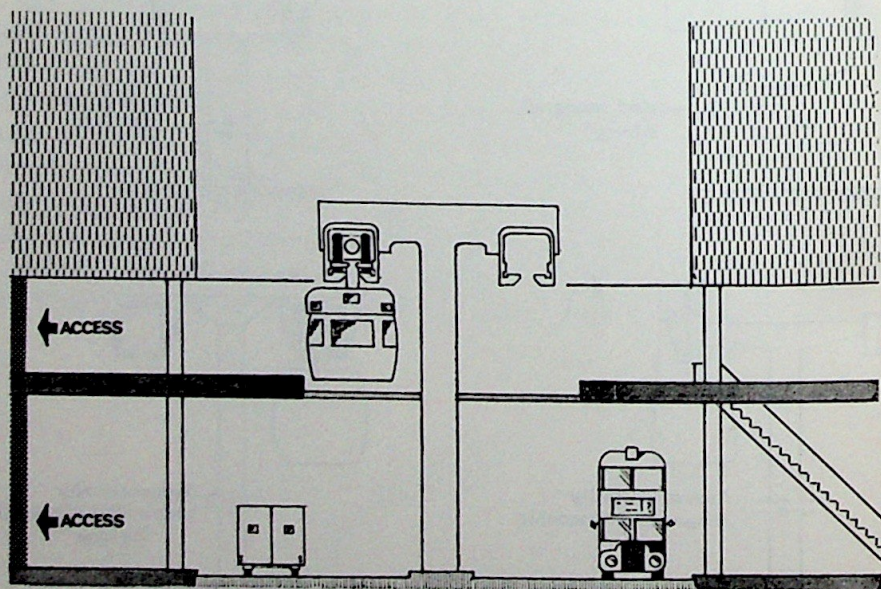
Here are some generally accepted types. They are all common and



Different types of elevated construction



Monorail along city street



Access to buildings at first-floor level

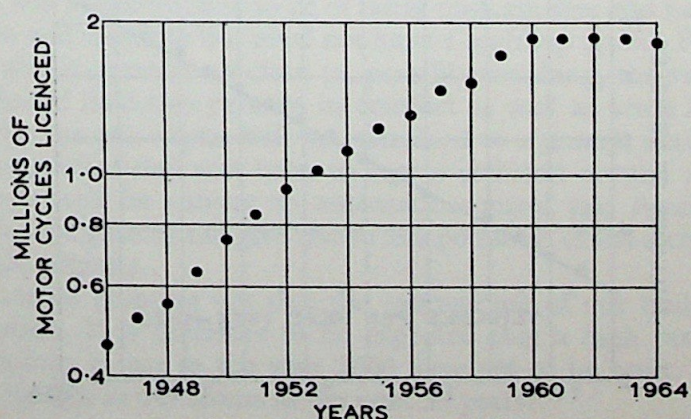
employ pneumatic tyres, running on some form of concrete structure. First is shown a supported monorail, then the track-guided trainway, the asymmetrically suspended monorail, and the symmetrically suspended monorail, exemplified by the Safege system. These systems offer speed, silence, and comfort; furthermore, they can be built rapidly and put into use in our large towns and cities at the rate necessarily to deal with the problem.

The next figure shows a monorail installation along a city street and the last shows the way in which it can be related to the remainder of the city, allowing access to buildings at first-floor level.

Mr R. J. Smeed

We are here today to talk about traffic in the year 2000. But it is important to realize that, although the nature of man can hardly alter appreciably in the next 35 years, some of the conditions in which he is living can alter, and may do so in ways which many of us would not now expect. We must consider future possibilities but at the same time recognize the possibility of error. I will take two examples to illustrate this possibility.

The first diagram shows the number of motor cycles licensed year by year since the end of the 1939-45 war. You will see that there was a fairly steady increase in the number of motor cycles until 1960. Anybody looking at the data in the year 1960 might, I think, be forgiven for

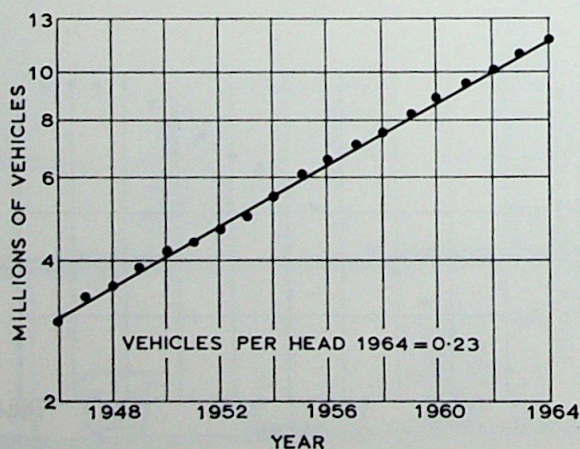


Number of licensed motor cycles in Great Britain

believing that the number of motor cycles was likely to continue to increase for a further period. But, in fact, no such increase occurred. There was a slight decrease. Using data up to 1960 one of my colleagues tentatively suggested that there might be 2.4 millions of motor cycles in 1964. The actual figure was 1.8 millions.

A similar situation has occurred in predictions of population. In the 1930s it was generally thought that the population was likely to decrease. Even after the war, the Royal Commission on Population gave 43-52 millions for the population of Great Britain in the year 2000. The latest official estimate is 70 millions. The Government Actuary has repeatedly pointed out the possibility of error in the projections that he makes of the number of future births. Both of the predictions mentioned were made with considerable competence and we must, I think, conclude that we cannot predict many aspects of the future with confidence.

Realizing that our predictions may be wrong, we must nevertheless examine present tendencies to see where they lead. The next diagram, therefore, shows the total number of road motor vehicles registered each year since the end of the war. The percentage rate of increase is even more steady than that for motor cycles. One can go further by examining in detail the figures for different types of vehicle in different parts of the country. Such an examination shows relations between the numbers of vehicles per head and the rate of growth of vehicle ownership. Assuming that the relations obtained will be similar in the future



Number of licensed vehicles in Great Britain

my colleague, to whom I referred above, although not very successful with regard to motor cycles, has been very successful with respect to total numbers of other motor vehicles. He predicted an increase of 3.0 million other motor vehicles between 1960 and 1964. The actual increase was 3.0 millions. His latest projections suggest a figure of about 36 million vehicles of all types in the year 2000, three times the present figure. I think that this prediction is about as good as can be made at present but we must realize that it is not only subject to error but possibly to considerable error. However, although the number of vehicles in use in the year 2000 may be higher or lower than 36 millions, we must accept the possibility of this number and we should therefore consider how to accommodate them. Analysis shows little difficulty in accommodating them on the main rural roads, provided there is sufficient expenditure on improvement of existing roads and on new construction. However, if the larger British towns are to retain their present shape and density of development great difficulties are bound to occur in them if very large numbers of commuters attempt to travel by car during peak travel periods. We should, of course, consider the desirability of continued reliance on public transport, including the possible use of pedestrian conveyors that can cross one another and operate successfully at a reasonable speed. We should, however, also consider the possible development of cars, especially for use in towns during peak travel periods. This would be in addition to the continued development of private vehicles for other purposes.

The town car needs to be small so that it will occupy the minimum of space both when at rest and when in motion and highly manoeuvrable at low speed so that it can be parked in small space. At present, less than one-third of the total area of car parks is actually occupied by cars. Town cars will probably have to be of fairly uniform size and have good acceleration and visibility but need not have a high top speed. Each one should be able to travel very close to, possibly touching, the vehicle in front. It should hold two persons in comfort as well as some luggage. I expect that the passengers will be restrained to a greater extent than they are by present-day seat belts in case a collision occurs. All road vehicles may well be subject to automatic control and future town vehicles must be quieter and give rise to less pollution of the atmosphere than present vehicles.

I conclude by pointing out that the average life of our buildings is about 60 years. It is therefore to be expected that a high proportion of the buildings in use in the year 2000 have yet to be built. We can make big changes in our towns in the next 35 years.

Mr F. R. Murray

I wish to comment on two points connected with the method of travel and means of transport in the year 2000; my remarks apply to travel in towns.

First, with regard to the method of travel, I would suggest that some extrapolation of the role of the owner-driver in the use of his town carriage can be carried out. This is not based on carefully collected statistics but is perhaps a basis for discussion. Eighty years ago, most 'town carriages' were chauffeur-driven; forty years ago, about half were owner-driven; and now, in 1965, most are owner-driven. So if we carry on the process of eliminating the human element, we may predict that, forty years from now, automatons will take on half the work of directing town carriages. Eighty years from now, most town travel may be automatic.

In towns built as automated units, this will mean that the private motorist will travel from X_1, Y_1, Z_1 to X_2, Y_2, Z_2 by dialling his way there in some mobile box taking its energy cleanly and quietly from the mains. In this way public and private transport will emerge. There may be such developments in new towns; it seems likely that in others such changes will be slow to come. In towns not differing much in general layout from those of the present it will be impossible to exploit the use of press-button control and mobile boxes taking their power cleanly and quietly from the mains.

This brings me to my second comment, which is to compare in a very general way the methods of propulsion which may be used for town carriages in less sophisticated towns of the future, when absence of atmospheric pollution, noise, and complication will weigh heavily in the balance of pros and cons.

Type	Fuel	Fuel conversion	Motor	Transmission and controls	Total
Petrol	8	20		20	48
Petrol clean and quiet	8	40		20	68
Battery		700	70	10	780
Fuel cell	8	180	70	10	268

Small short-range vehicles: weights of fuel plus power plant

In the table a comparison has been made between the weights, shown in pounds, of the fuel plus power plant for four ways of driving a small car. The car is assumed to need a maximum power of 10 hp and to have a range of 10 hp h of travel. The comparison is influenced somewhat by the choice of range. The first column shows the weight of the fuel which, in all but the case of the battery, is separate from the item in the second column, which is the weight of the means of converting the fuel to energy. The third column is the estimated motor weight. In the fourth column, an estimate is included for the weight of transmission and controls. The final column shows the total weight.

The first line shows the figures for a high-performance small petrol engine. Here a figure of 0.8 lb h b.h.p has been used as an overall specific fuel consumption and the engine is assumed to weigh only 2 lb/hp. In the second line the engine weight has been doubled to allow for weight of silencing and exhaust detoxing. In the third line, figures are shown for a lead-acid battery as the fuel-plus-fuel conversion unit. The electric motor is assumed to weigh 7 lb/hp; the weight of controls and transmission is only half that associated with the petrol engine. In the last line, figures are shown for a fuel-cell power plant. The figures are based on a slightly pessimistic interpretation of those published by Poulston and Kirtley* last year.

Although a battery power plant might seem to be the natural candidate for the job of town-carriage propulsion its showing in this Table is disappointing. A comparison on the basis of bulk is less unfavourable to the battery; the bulk of the battery as a source of energy is only about three times that of the bulk of either the petrol or fuel-cell system. Following a suggestion made by Stephen Bragg, it appears that, if one regards a lead-acid battery as a lead-burning energy producer, nine-tenths of the weight of the present-day battery is spent on conversion because only one-tenth of its weight is required for the fuel used in its output.

It would be interesting to have a treatise from experts in the field on the prospects of developing a battery of suitably reduced weight for town transport in the year 2000.

Professor C. J. Milner

The great virtue of the motor car is its ability to convey the individual from A to B, from Here-Now to There, with minimum delay. This is something that public transport, running on scheduled routes, can only do best in very crowded areas. My forecast is that in the year 2000 the use of individual cars will continue to be very widespread; furthermore,

* POULSTON, B. V. and KIRTLEY, J. G. 'Possibilities for the fuel cell in the passenger car', *Proc. Instn mech. Engrs, Lond.* 1963-64 178 (Pt 2A), 111.

my forecast is that automatic vehicle control will have largely ousted the human driver.

This development must be increasingly pursued, I believe, because only so will the toll of road accidents be reduced.

At the Road Research Laboratory and elsewhere work is in progress to develop means for vehicle guidance and control such as are popularly called 'the electronic highway'; a long-term objective being to guide each vehicle, on a motorway with access restricted to properly equipped vehicles, so that it keeps in lane and at a safe spacing from the next in front. This is, of course, the sort of scheme that Zworykin and his co-workers have pioneered.

The best methods of doing this are doubtless to equip the roadway with guidance-cables, spacing-computers, etc., and thus make the road control the vehicles. In a sophisticated version, such a system could allow overtaking and merging of traffic to take place when safe, and only when safe. Exit from the motorway at a prescribed point could be readily programmed.

In a wider sense, however, automation of motor cars requires automatic collision-avoidance on the open roads and steets also. Such equipment is probably best all mounted on the individual car.

For collision-avoidance on the open road, which is the goal towards which my own work is directed, both at present in the Road Research Laboratory and at the University of New South Wales, one requires that the position and relative motion of each near object shall be observed about once every second. Microwave beams seem most suitable for sensing by reflection objects, metallic or dielectric, that are sufficiently bulky and upstanding to be collision hazards. Doppler techniques allow measurement of relative velocity as well as of range. For detection of a man at 100 ft or a car at several hundred feet, a transmitted power of less than 1 mW suffices. This is within the range of all-solid-state electronics already. Mutual interference is not thought to be a significant problem. The data on position and relative motion of each object must then be used to evaluate whether collision with it is imminent or not; and if so, what evasive action (normally steering aside) should be taken.

There are two problems here, both of some difficulty but not, I think, beyond solution. One is the technical one of determining the dimensions of an object detected by radar. A radar reflection comes effectively from an ill-defined point on an object, whereas visually one perceives the outline of the object and thus its extent. It may be that infra-red lasers will solve this problem. The other one is more theoretical and arises from the necessity, in ordinarily dense traffic, of allowing for the non-circular, oblong, shape of road vehicles and the attitude

of their approach. The criterion of whether collision is or is not predicted must be a highly complicated function of all the above-mentioned data if the routine passing of two vehicles 20 ft long and side-to-side with 10 ft between their centres, as is common on the roadways, is not to give the alarm. This problem has at least been fairly clearly formulated and analysed quantitatively: how to decide each case remains a problem.

On the assumption that this can be done, safe pilotage essentially comprises a multitude of such decisions. Individually simple, there is at least hope that they could be effectively taken in rapid succession by automatic means.

I have given reasons for preferring collision-avoidance to be a function entirely of vehicle-borne apparatus. Communication with ground-based equipment is, I think, more realistically to be used for the other part of pilotage, in which the pilot, to wit the auto-pilot, must decide on and follow a route as well as avoid collisions while doing so. Of course, the occupant of the car could dictate the route, pushing buttons for 'next turn right', 'fourth turn on the left', and so on. But an important function of the auto-pilot would be to eliminate street parking by having the empty cars drive themselves away, perhaps to a parking station, perhaps to their next user. At least at such times, route instructions from a ground base are required.

This leads me to round off my forecast by picturing a population of pilotless taxis, radio-controlled so that one cruising in a neighbouring street stops at the door of any house calling for it by telephone dial, and on being entered and given its destination by a dial within it or by radio-telephone to a central control station, takes off and drives itself there, avoiding collisions en route. With the vast economies of solid-state electronics already maturing, I think one need not be much alarmed by considerations of cost. Please bear in mind that it is already as cheap to hire a self-drive car and to leave it idle all day as to own a car: the cost of motoring could be much less if the car were hired only while in use: and this will be a *drive-itself* car not a *drive-yourself* one! Can it perhaps be made more skilful as well as more reliable than a skilful and reliable chauffeur?

The Chairman

We have heard a very wide range of views, but there has been nothing from the medical profession. I wonder if Dr Ellison of the Medical Research Council would like to speak on health?

Dr J. McK. Ellison

To begin with I must state that I am standing in for Dr Lawther, Director of the Medical Research Council's Air Pollution Research Unit, and that he is a medical doctor which I am not. Probably I am in a better position to appreciate the medical implications of air pollution than many of you here are, but I am a physicist.

The first thing that struck me as I listened to the other speakers this evening was that they anticipated a very great rise in the use of 'personalized transportation', as I think the Americans like to call it, in towns in this country in the next 35 years. One or two of them mentioned air pollution in passing but it was not very much stressed. Already in Britain, however, road vehicles are causing quite a serious problem of air pollution in city streets. The pollution they cause is not noticed so much as that which comes from chimneys and it has not yet really caught the public interest, but I think that, before very much longer, it will begin to do so.

It is only about 100 years since the public apparently did not notice the enormous quantities of hydrochloric acid emitted by the chemical industry, and only 35 years ago, in the thirties, I remember my father regarding air pollution as something which, like the poor, was always to be with us. Now, however, the public has become very much aware of it and I think that a public which is becoming more and more conscious of its rights is likely to include pollution-free air among them in the next 35 years. At the moment the principal pollutants from road vehicles are smoke from diesel engines and carbon monoxide from petrol engines. I expect most of you know but I should like to stress that it is not difficult to operate diesel engines so that they do not emit smoke and that they do not produce appreciable quantities of carbon monoxide. The carbon monoxide produced by petrol engines is a more difficult problem, and on a number of occasions concentrations of it have been measured in the street that are greater than the maximum allowed in industrial premises for the working man: the maximum allowable concentration in working conditions is 100 p.p.m. and we have measured very much higher concentrations than that from time to time in London streets, as have other workers elsewhere.

It is a very serious problem because, in fact, carbon monoxide is an essentially insidious toxic agent and it acts very largely by reducing mental alertness. From that point of view, I was very interested in the suggestions that, in fact, mental alertness would not be relevant in the year 2000 and that, although we might all be poisoned by carbon monoxide, an automaton would deliver us at our destinations unbruised.

We will be subjected to this type of pollution, and its results, unless something is done to reduce the emission by road vehicles. That

I think, is essentially a problem for the engineers. Those who are interested in air pollution only try to clear up the mess that has been put in the air by others, and our problem will not have been formulated until you have told us how you propose to solve yours.

Mr C. G. Woodford

I should like to make one or two suggestions which should contribute to the solution of some of our transport problems during the next 35 years. One of the things of importance, mentioned a long time ago in the Abercrombie Report for London, was the suggestion of splitting up the main-line trains coming into London between 25 and 35 miles out: splitting them up into left, right, and centre and taking them down underground to the level of the inner circles by three separate electric locos. Instead of having to engage porters and have luggage transported from one underground station to another, they would already be at that part of the inner circle where they were wanted. That would cut out 30-35 per cent of the cross traffic between main-line stations at the present time. The solution would then give us radial arterial roads running out from the present terminal centres, which are important centres and junctions of traffic in London, to the main arterial roads on the outskirts, meeting the road system 25 to 30 miles out. This is done, to an extent, in New York already.

A second suggestion is that, whereas we have been investing millions of pounds in concrete motorways, the real problem of high-speed transport in this country through the middle of the country, from London to the South, to the Midlands, Scotland, and the North, is largely due to the fact that we have not been able, for 50 years, to increase the train density on the midland trains. The way to solve the problem is to put down one extra railway line on each side of the track so that we can run trains at one-and-a-half times their present speed, stopping them at only half the number of principal stations at which they now call. We would then have a cheaper solution at higher speed than is achieved by building motorways where every individual car and driver gets fatigued through trying to keep up the sort of speed that the railways can do without these troubles and with the utmost ease.

After that, having made the main lines pay on a much more efficient basis, the next thing is to realize that you cannot run long free-line services without feeders. We still need the feeders which Dr Beeching has thrown away. The way to do it is by branch-line stations. The branch-line commuter only needs transport at 15 mile/h to take him from his village station to the main-line station. That only requires a couple of coaches with a battery-operated loco in between them with a

charging point at the end station and on the main line. It can be run by the postman or the milkman in between their normal rounds. The local passenger puts a shilling in a slot, goes through a turnstile, takes his seat, and gets to the main-line station and buys a ticket. When he comes back, he puts another shilling in the slot and goes back to his home station. I believe that a combination of these two suggestions would make the whole British rail system pay. I do not ask for £24,000 a year to do it.

My next point concerns aspects of town planning. Here I must speak with my tongue in my cheek in the present company because I am at present living at Bath, and having come up from there tonight, I believe that Bath is the exception; but what I hope to see in English towns within 50 years is a return to the main-road system of cross-roads at the towns which we have been building up for the last thousand years, but 100 ft above present street level. We shall have in any case, sooner or later, to cover in the centres of our towns so that people wearing evening dress or soft shoes can move in a central civic area from ballroom to guildhall, from conference hall to hotel and theatre, in escalators and travelators. I believe that car parks will be quadrant d-sections out of the towns and that main roads will go back to the present lines on the map and will be over the towns. I am not in favour of building tunnels underneath. We can always build higher. We can carry our main roads over the towns of 3-10 square miles.

Towns and cities, which will eventually have populations of 100 000, or 400 000, or 1 600 000, will be built in rings around a central civic area. The first ring, immediately around the centre, will consist of public buildings, main shops, and principal offices. The second will be a residential area for the wealthier citizens. Then will come roads of shops and finally an outer ring of factories and a ring of dwellings for factory workers which will be surrounded by green open countryside. The masses of the people will thus live on the edge of the country and the factories will be just inside them in the towns.

Mr R. Gresham Cooke

I hope I shall not be accused of throwing a spanner in the works but I have listened with great interest to these great dreams for the next 35 years. I hope they come true but I am beginning to wonder how far we shall get in 35 years. I cast my mind back over the last 35 years. I had just come up to London in 1930, having been at Cambridge, and I try to remember what happened in the thirties: coming from Cambridge to London, one took a train from Cambridge Station to Liverpool Street Station. That is all exactly the same. One came out of Liverpool Street Station and caught a No. 11 bus; that is still there. Or one went on the

Central London Line in coaches which were made in about 1930 and are still running. Or one took a taxi, and that looked in 1930 exactly the same as it does today. Or, again, one had an Austin Seven to come from Cambridge, and that is still not so very different. The engine is still at the front! The only change is that the drive is to the front wheels instead of the back.

Without being too pessimistic, I just want to say that we have not progressed very far in the last 35 years; perhaps, with our knowledge and so on, we shall progress a great deal faster in the next 35. With all our brains here, I greatly hope so.

I should mention that we had one further advantage in 1930. There was free competition on the road for buses and so one could still go from Cambridge to London by coach on an hourly service. I do not think this is possible today.

Mr F. G. Parnell

I rather think that most of the speakers this evening have not stood far enough back. Thirty-five years, of course, is not a long time; but I should like to stand back for a moment and consider this little island and its population and think what kind of transport system we should like to have in it without being governed by the kind of transport system we have got in it.

If our enormous population is to live at all happily in this tiny island, it has to be spread out. A lot is said about congestion in the South-east. You will never get the population spread out unless you make the transport suitable.

I should like to give an illustration. A man has a 30-storey hotel. He is rather bothered by the cost of running lifts so he gets an expert in who watches the lifts and checks the loading, etc. He discovers, rather surprisingly, that the traffic from the 20th floor to the 30th floor is nothing like as heavy as that from the 1st floor to the 20th floor, so he decides that he will cut out all the lifts above the 20th floor and let the customers walk. What effect will that have on the hotel?

As long as all railway lines radiate from London, the sensible businessman who wants to get to all parts of the country says, 'I must have my office in London. It is the only place where I can have reasonable access to Edinburgh, Glasgow, Bristol, Manchester, and Birmingham.' There is nowhere else you can go. Having parked himself comfortably in London, not being fond of excessive journeys, he says 'I want my factory somewhere in the Home Counties' so he plants his factory in the Home Counties.

I do not think, unless you are on a leisurely holiday, travelling more than 100 miles in a motor car makes any sense. I do not think that

travelling in a railway train – I am not speaking of commuter traffic – for less than 60 miles makes any sense. I do find, ignoring present conditions altogether, that it is quite possible to set out a railway network comprising about 30 stations which would cover the entire British Isles south of Edinburgh so that nowhere in the country would be more than 30 miles from a railway station. It also seems to me to be possible, with modern railway techniques and electric traction, etc., to provide from every station in the country a one-hour service to every other station in the country. That may sound crazy. I have not time to go into it but it seems to me it is a possibility. It might be only one coach but there would be a service.

Having got this network, every journey has three parts: you have to get from your home to the station, you have to take your railway journey, which can be very pleasant and comfortable, and when you reach the other end you have to get to your destination. You get to the railway station and find that it is on the outskirts of the town. There is no bus, no taxi, and you are completely sunk. My suggestion is that every railway station, and there would only be about 30, should have a complete service of cars. Several people have discussed motor cars. I think the modern car which requires contortion to get into it is possibly ideal if you want to put it outside the house on Sunday morning to polish it, but as a serious means of transport, it is a bad joke. We need something much simpler, probably electric, with a bumper all round it. I think you should buy a season ticket which would entitle you to the use of a transport company's car in your home town and then at whichever of these 30 stations you go to, you present your pass to the man at the station and he provides you with one of the transport company's cars which you can then drive to where you like and leave at any station you like. On journeys to London I should leave the car at Leamington and anyone going to Leamington could use that car for his local journeys.

Present railway arrangements seem to be made on the assumption that the passengers consist entirely of stationmasters visiting their colleagues. The entire journey must be considered if people are to be persuaded to use the railways. Super trains on a few routes are of no interest whatever to most of us.

Mr J. W. Jordan

I am interested in urban public transport. Mr Lloyd has come very close to this interest and, in my belief, to a good solution of the problem with the minimum of difficulty. This is the modern form of the tram-car. Tramways are in use on the Continent in a number of towns and are being developed in some of them to a high degree. They fulfil the

idea of bus lanes and also that of a rail service which has a comprehensive network similar to the Paris Metro, but at a much reduced cost compared with that of the Underground. The Underground requires signalling, tunnels over most of its route mileage, a considerable amount of expensive rolling stock, and facilities such as ticket collection. Tramways may be built on the surface or in subways if necessary; they can be built elevated, as with the trackway, in one of the four forms of monorail mentioned previously, and can follow the contours of the land, including steep gradients, with little need for earth moving. There are considerable stretches in the less densely populated areas outside town centres where there is room for the track to be laid on the surface at the side or in the centre of roads and behind houses in places. The system such as the one planned for Brussels would probably be ideal for a number of towns in this country. The tramway system would be laid down on reserved track on the outskirts of the town and in the suburbs so that no section of the suburbs could be any great distance from it. People living at a distance from a tram route would take a feeder bus. In the centre of the town the trams would be run on more concentrated routes and eventually into subways under the road in which they could be run as multiple units. When the scheme was finally completed an average operational speed of 17 mile/h would be achieved with stops at intervals of approximately 400m, which is greatly superior to an efficient bus service and approaches the standard of a full underground service.

A monorail is a form of inverted tramcar. It has some of the tram's advantages but both aesthetically and functionally it is a little dubious, and if tunnels have to be built, the monorail loses a lot to conventional railed transport because it requires greater tunnel area, which is more expensive to construct.

It seems to me that consideration should be given to the tram for future light rapid transport. It also lends itself to integration with pedestrian environmental areas in new town development.

I think I can safely predict that by 2000 we shall see new towns with tramway systems in Great Britain.

Mr J. T. R. Lewis

I consider that the composition of transport in a conurbation needs to be studied in further detail and I suggest that each of us should examine his journey to and from work to see whether a little self-sacrifice now could provide a better journey, not only for ourselves but for many fellow travellers.

The steady increase in the journey times for road vehicles, if allowed to continue indefinitely, will result in more and more reliance being placed on rail transportation and on walking in the year 2000.

The Chairman

We have had an interesting and full discussion. I think it would be only right to allow Mr Grylls and Professor Buchanan the opportunity of coming back again, if they wish.

Mr Grylls

The only thought that occurred to me during the evening was that if the Americans are successful in painting the Arctic Continent black and thereby preventing wind, we can all have airships made by Mr Norman. We shall get our third degree of freedom and go about in safety.

Professor Buchanan

I have made a number of interesting notes during the course of the discussion. Many ideas have come up to which I have listened with interest. But I am left with the impression, at the end of it, particularly as a result of some of the things said about resuscitating rail travel in various ways, that we have to recognize the hard fact that when man invented the motor vehicle he really invented a form of transport which is more useful than any other form of transport yet thought of. I think it will be with us for a long time. I think it will be worth while looking at towns and cities in the future in a creative way to see what ought to be done to them to enable mankind to reap the benefits of this extraordinarily versatile invention.

The Chairman

I feel you will not expect me to sum up the discussion. It has been very diverse and I think we have all taken in a number of points that will be reconsidered. One thing that is clear is that there will be serious problems. We are not unanimous on how to solve them at present but we think we shall be able to.

I should like to thank Professor Buchanan and Mr Grylls for their opening addresses, and all those who have taken part in the discussion.

List of Speakers

BUCHANAN, C. D.	C.B.E., Professor of Transport, Imperial College of Science and Technology.
COOKE, R. GRESHAM	C.B.E., M.P.
ELLISON, J. MCK.	B.A., Ph.D., Medical Research Council Air Pollution Research Unit.
GRYLLS, S. H.	M.A., M.I.Mech.E., Director and Chief Engineer, Rolls-Royce Limited, Motor Car Division
JORDAN, J. W.	G.I.Mech.E.
LEWIS, J. T. R.	A.M.I.Mech.E.
LLOYD, F. J.	B.Sc., F.I.A., F.I.S., Operating Manager (Central Buses), London Transport
MANSER, A. W.	B.Sc.(Eng.), M.I.Mech.E., Chief Mechanical Engineer (Railways), London Transport
MILNER, C. J.	M.A., Ph.D., Professor of Physics, University of New South Wales
MURRAY, F. R.	B.Sc.(Eng.), A.M.I.Mech.E., Assistant Chief Engineer, Rolls-Royce Limited, Motor Car Division
NORMAN, N. D.	Director, Britten-Norman Ltd.
PARNELL, F. G.	M.I.Mech.E.
PERRING, H.	M.A., M.I.Mech.E.
SMEED, R. J.	Deputy Director, Road Research Laboratory, Department of Scientific and Industrial Research
SUMMERFIELD, K.	M.Sc., M.I.C.E., County Surveyor, Oxfordshire County Council
TAYLOR, R. S.	Taylor Woodrow Construction Ltd.
WITHERS, J. G.	B.Sc., M.I.Mech.E., Vice-Chairman of the Automobile Division
WOODFORD, C. G.	

